FLEX

Facility for Low Energy eXperiments in Buildings

FLEX for Lighting – Use Case

Can industry reliably deliver high-performance lighting solutions at 1 kWh/(sf-yr)?

The Challenge

Lighting is one of the largest loads in commercial buildings, and low-power density (W/sf) installation requirements are increasingly common. However, gains in energy-efficient lighting of the size required for deep retrofit savings and zero-net energy buildings will require a shift to **performance-based metrics and design goals.**

What do designers, engineers, and manufacturers need to develop advanced lighting control systems capable of **delivering low-energy lighting solutions, while maintaining indoor environmental comfort** and occupant satisfaction?

FLEX offers a unique opportunity for industry and researchers to collaboratively solve 'stretch' problems of this nature. **Consider the low-EUI lighting challenge**, and how **FLEX** provides a path to solution that cannot be found anywhere else in the world.

Starting Point

A manufacturer has a **new lighting controls solution targeted for retrofit** applications that provides daylighting harvesting and occupancy control, setpoint tuning, and occupant personal control. The system has been bench-tested, component-tested, and function-tested in demonstration room environments. It has not undergone long-term performance testing with continuous high-resolution field-measured data.

Solution Pathway

System **performance validation in FLEX's 1980s vintage testbed**, with identical side-by-side test cells.

The manufacturer conducts a six-month field test, leveraging testbed measurement capabilities for energy performance and occupant comfort assessments that were not possible in the manufacturer's company facilities.

Testing lighting controls.

Testbed Capabilities	Performance Parameters and Benefits
Horizontal and vertical photometers	Visual comfort – contrast, glare, ability to maintain worksurface illuminance
Lighting system and fixture power	System energy use, and peak demand; energy savings vs. 1980s base-case in twin cell; satisfaction of the 1kWh/(sf-yr) target
HVAC energy use	HVAC impacts; whole-building or zone energy savings due to retrofit system
Reconfigurable interior spaces	Impact of changing reflectance, geometries, and sensor locations
State of pre-existing shading devices (optional)	Impact of shading on energy and visual comfort
Exterior daylight conditions – cloud cover, irradience, sun position	Impact of exterior conditions
Robust data acquisition, accommodation of additional instrumentation	Flexibility to integrate experiment-specific measurement with existing testbed sensors
Ability to interoperate and execute control across a variety of platforms and devices	Flexibility to test diverse systems and components, control solutions, and proprietary systems

Immediate Outcomes

- Validated **system energy savings relative to the 1kWh/sf-yr target**.
- Optimized sequences of operation, energy and comfort performance metrics, whole building energy savings and HVAC dependencies.
- Holistic archival set of **high-quality field-measured data** (dozens of points) for use in manufacturer documentation and publications.
- Comprehensive experimental results to adjust system control logic, or component performance, if energy or comfort targets are not met.

Extended Validation & Deployment Opportunities

- Conduct a performance test in **FLEX's rotational testbed** to determine performance under diverse orientations.
- Introduce occupants through **human subjects testing** – shift experimental focus to occupant satisfaction and personal control.
- Use the virtual design testbed, and simulation tools such as Modelica and Radiance to develop robust calibrated models; **partner with LBNL researchers with subject matter expertise**.
  - Use field-measured data to **extend experimental findings – diverse climates, room geometries, envelope, and HVAC systems.**
- Identify **critical performance drivers** and associated measurement solutions **for operational diagnostics, continuous commissioning, and reporting.**
- Build partnerships with **early-adopter FLEX members** to conduct scaled demonstrations in real-world buildings across the nation.
- Use experimental data, in combination with access to **utility/state testbed members**, to expose benefits to new incentive programs and future code requirements.
- Provide anonymized system design and operational performance data to members of the **architecture & engineering community** using the virtual design testbed.
  - Industry-standard design and simulation tools support designers to gain confidence in specifying the low-energy retrofit lighting system.

References and Further Reading

Granderson, J, Gaddam, V, DiBartolomeo, D, Li, X, Rubinstein, F, Das, S. Field-measured performance evaluation of a digital daylighting system. 2010. Leukos, Journal of the Illuminating Engineering Society of North America 7(2): 85-101.

Wen, Y-J, DiBartolomeo, D, Rubinstein, F. "Co-simulation Based Building Controls Implementation with Networked Sensors and Actuators," Proceedings of the 3rd ACM Workshop on Embedded Sensing Systems for Energy-Efficiency in Buildings (BuildSys'11), 2011.